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Research Article

A NEW *Suaeda* RECORD FOR FLORA OF TURKEY: *Suaeda aegyptiaca* (Hasselquist) Zohary (CHENOPODIACEAE/AMARANTHACEAE)

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Abstract: In this study, *Suaeda aegyptiaca* (Hasselquist) Zohary is reported as a new record for Turkish flora from Akçakale district in Şanlıurfa province. The species is classified under section *Salsina* Moq. of the genus *Suaeda* Forssk. ex J.F. Gmel. in *Suaedoideae* subfamily. The comprehensive description, distribution maps in Turkey, habitat features, morphological characteristics and digital images of the species are given.

Özet: Bu çalışmada, Şanlıurfa ili Akçakale ilçesinden *Suaeda aegyptiaca* (Hasselquist) Zohary türü Türkiye florası için yeni kayıt olarak verilmektedir. Tür, *Suaedoideae* altfamilyası, *Suaeda* Forssk. ex J.F. Gmel. cinsi *Salsina* Moq. seksiyonu altında sınıflandırılmıştır. Türün kapsamlı betimi, Türkiye'deki dağılış haritası, habitat özellikleri, morfolojik karakterleri ve fotoğrafları verilmiştir.

Introduction

Suaeda Forssk. ex J.F. Gmelin (Chenopodiaceae Vent./Amaranthaceae Juss.; Suaedoideae) is a halophytic genus and is represented by about 100 species worldwide (Ferren & Schenk 2003, Brandt *et al.* 2015). The genus has a cosmopolite distribution and the majority of taxa are spread in saline and alkaline soils.

The genus is taxonomically represented by two subgenera as *Brezia* (Moq.) Freitag & Schütze and *Suaeda* and eight sections are associated with them (Schütze *et al.* 2003). Different researchers conducted systematic (Schütze *et al.* 2003, Kapralov *et al.* 2006, Brandt *et al.* 2015) and taxonomic studies (Schenk & Ferren 2001, Lomonosova & Freitag 2011, Freitag & Lomonosova 2017) at tribus, genus and sectional levels, primarily within the *Suaedoideae* subfamily. Three new species were described in the last two decades (Lomonosova & Freitag 2003, Alonso *et al.* 2004, Noguez-Hernández *et al.* 2013).

In Turkey, the first study on the genus was conducted by Aellen (1967) and a total of seven species were reported in the second volume of "Flora of Turkey". Then, *Suaeda linifolia* Pallas was added in the tenth volume (Davis *et al.* 1988) and *S. splendens* (Pourret) Gren. & Godron was recorded in the eleventh volume by Freitag (2000) making the total number of species nine (Yaprak 2012).

Suaeda aegyptiaca (Hasselquist) Zohary was firstly evaluated under the name of *Chenopodium aegyptiacum* Hasselquist in 1757 and was used with that name until mid-20th century. However, in the study conducted by Zohary in 1957, *Chenopodium aegyptiacum* was transferred from the genus *Chenopodium* L. to the genus *Suaeda* and republished under the name *Suaeda aegyptiaca* (Zohary 1957).

The species is distributed in three continents and in a total of 23 countries, which are in Mediterranean (Cyprus), north Africa (Tunisia, Libya, and Egypt), northeast Africa (Sudan, Eritrea, Ethiopia, Djibouti, and Somalia) central and southwest Asia (Afghanistan, Pakistan, Iran, Iraq, Israel, Lebanon, Syria, and Jordan) and Arabian Peninsula (Saudi Arabia, Yemen, Oman, United Arab Emirates, and Kuwait) (Powo 2021, Wikipedia 2021). The species is also present in South Australia as naturalized. The distribution of *S. aegyptiaca* in Turkey remained unknown until this study.

The aim of this study is to give the record of *S. aegyptiaca*, a new species of the genus, from Şanlıurfa and give some informations about the species.

Materials and Methods

The material of the study comprises the plant samples collected during the fieldwork conducted between the years 2018 and 2019. The samples were pressed and dried, as required by common herbarium rules. The samples were identified using the volumes of "Flora of Turkey" (Aellen 1967, Davis *et al.* 1988, Güner *et al.* 2000) and

the flora of neighboring countries and the relevant literature (Zohary 1966, Tackholm 1974, Meikle 1985, Hedge 1997, Freitag 2013). In addition, digital photographs of the samples associated with the species in international herbaria [BM, BRY, C, E, DES, HGB, P, S, U, WAG (acronyms according to Thiers 2021)] were examined and compared with the specimens. The identified specimens were deposited in the herbarium collection of Ankara University, Faculty of Science, Department of Biology (Herbarium-ANK).

Digital measurements of all morphological characteristics of the specimens were taken using the BAB stereo binocular microscope and the BAB image processing and analysis system (Bs200Pro) using both the dry samples and the samples fixed in 70% Ethanol solution.

Results

Taxonomic Treatment

Suaeda aegyptiaca (Hasselq.) Zohary

≡ *Chenopodium aegyptiacum* Hasselq., Iter Palaest. 460 (1757).

≡ *Schanginia aegyptiaca* (Hasselq.) Aellen in K.H. Rechinger, Fl. Lowland Iraq 195 (1964).

= *Suaeda baccata* Forssk. ex J.F. Gmel., Syst. Nat. ed. 13: 503 (1791).

Type : Alexandria, Fl. Aeg. Arab. p. LXIV N186 p. 69 Cent. III N15 hodie *Suaeda baccata*, September 1761, P. Forsskl 164 (holotype C, photo!).

= *Schanginia baccata* (Forssk. ex J.F. Gmel.) Moq., Chenop. Monogr. Enum. 119 (1840).

= *Suaeda hortensis* Forssk. ex J.F. Gmel., Syst. Nat. ed. 13, 2(1): 503 (1791).

Syntype: Taizz, Fl. Aeg. Arab. p. LXV N188 p. 71 Cent. III N21 hodie *Suaeda hortensis*, 1763, P. Forsskl 145 (C and S, photo!).

= *Schanginia hortensis* (Forssk. ex J.F. Gmel.) Moq. Chenop. Monogr. Enum. 119 (1840).

Plant annual and herbaceous, in early period light green, in late period dark green, glabrous. **Stem** up to 100 cm high, erect, ascending, or rarely decumbent, much and repeatedly branched, branches erect or ascending, the lower often spreading, terete or delicately striate; in young condition pale green throughout, later turning whitish to cream-colored; stem and all branches woody in fruiting time. **Leaves** 7.0-35.0 x 1.5-3.5 mm, succulent, linear or oblong, kidney-shaped in cross section, margin entire, apex obtuse, sessile or at base attenuate into a short petiole, the lower straight, the upper arcuate, ascending to spreading. **Inflorescences** leafy, shorter or longer spike-like, loose or dense, in apical parts often flexuose, axillar and glomerate; **glomerules** 1-30 flowered, 0.5-1.0 cm diameter, alternate arrangement, inserted on very short axillary branchlets, sometimes fused for a very short distance with the petiole of the leaves. Bracts and bracteoles present. **Bracts** 1, 1.0-1.7 x 0.5-1.0 mm, ovate, ovate-deltoid or deltoid, membranous, margin entire or lacerate, apex acute or acuminate, equal or longer than bracteoles. **Bracteoles** 2, 0.6-1.5 x 0.3-0.8 mm, ovate or ovate-deltoid, membranous, united with each other at the base, apex acute or acuminate, margin lacerate. **Flowers** hermaphrodite, 1.8-5.0 x 2.0-5.5 mm, fig-shaped, sessile or rarely with a very short pedicel. **Perianth** segments 5, segments 0.8-2.7 x 0.8-2.2 mm, succulent, united up to 1/2 or 2/3 the length, obovate or oblong, incurved, green with hyaline margin. **Stamens** 5 to numerous, 0.7-2.0 mm, inserted on a disc above the middle of the ovary; **staminode** absent; **anthers** yellow, 4-thecous, 0.45-1.0 x 0.30-0.75 mm, oblong, united to 1/2, open up longitudinally; **filaments** 0.40-1.80 x 0.08-0.30 mm, in the early period short and after anthesis elongating. **Pistil** 1, 2-3 carpellary, 1-lolcular, 2.20-4.50 mm; **stigmas** 2-3, 0.80-1.75 mm long, filiform, with long papillate, light brown; **style** 0.55-1.30 mm long, terete or partly conical, membranous; **ovary** inferior, 0.75-2.0 x 0.5-2.0 mm, obconical, brown. **Fruits** up to 5 mm long, fig-shaped, partly or completely spongy. **Seeds** vertical, 0.8-1.5 x 0.6-1.1 mm, slightly flattened; testa black or reddish, lustrous, with reticulate surface.

Type: [Egypt] "Alexandria rudera prope maris Mediterranei litus" (according to Freitag 1989, it is probably lost).

Material: TURKEY: C7 Şanlıurfa province, Akçakale district**,** Akçakale-Ceylanpınar road, ŞUSKİ waste water treatment facility, on the road of Öncül village, approximately 1-1.5 km, irrigation channel, road and field edges**,** 344 m. a.s.l, 22.09.2018, 28.10.2018, 20.07.2019, N 36° 42′ 52.14″ - E 38° 58′ 48.37″ E, coll. İ. Başköse 4435, 4456, 4746 (ANK!).

Proposed Turkish name: *Suaeda* is called in Turkish **"Cirimotu"**. We propose **"Mısır cirimotu"** as a vernacular name for *S. aegyptiaca*.

Phenology: Flowering period in July; fruiting period September-October.

Habitat: In Turkey, the species is distributed in salty soils, near to irrigation and drainage channels, road or field sides at approximately 350 m. a.s.l. together with species such as *Polygonum equisetiforme* Sibth. & Sm., *Kochia scoparia* (L.) Schrad, *Chenopodium album* L. subsp. *album* L. var. *album*, *Tamarix smyrnensis* Bunge, *Alhagi pseudalhagi* (Bieb.) Desv., *Conyza canadensis* (L.) Cronquist, *Xanthium strumarium* L. subsp. *strumarium* and *Phragmites australis* (Cav.) Trin. ex Steudel.

Additional specimens examined: EGYPT: Alexandria, Fl. Aeg. Arab. p. LXIV N186 p. 69 Cent. III N15 hodie *Suaeda baccata*, September 1761, P. Forsskl 164 (holotype of *Suaeda baccata*, C10003145, photo!); Taizz, Fl. Aeg. Arab. p. LXV N188 p. 71 Cent. III N21 hodie *Suaeda hortensis*, 1763, P. Forsskl 145 (syntype of *Suaeda hortensis*, C-10003147, photo!); Cairo, Fl. Aeg. Arab. p. LXV N188 p. 71 Cent. III N21 hodie *Suaeda hortensis*, 1762, P. Forsskl 165 and 189, (syntype of *Suaeda hortensis*, C-10003148 and C-10003149, photos!); P. Forsskl s.n., (*Suaeda baccata*, BM-000069939, photo!); P. Forsskl s.n., (*Schanginia hortensis*, S-04/1003, photo!); (Sinai) in valle Hebran Arabiae petraeae, 9 July 1835, G.H.W Schimper-438,

(HBG-503718 and HBG-503718, photos!); Aegyptus, pr. Alexandria, Schimper, Georg Heinrich Wilhelm, s.n. (*Suaeda baccata*, COI-00052160, photo!); N. Sinai, El 'Arish, 27 km W of El 'Arish, Sand dunes and wet saline among the dunes, 17 July 1971, A. Danin, (DES-00021272, U-1059959 photos!). **ISRAEL:** North District, Kinneret, Upper Jordan Valley: 1 km. S. of Argaman, 301 m a.s.l, 13 September 1982, M. Zohary, WGS84, (DES-00026372, photo!); Eilath, Eastern outskirts of the town near the Red Sea coast, 2 April 1970, K.U. Kramer-4572, (U-1059960, photo!). **JORDAN:** Judaische Wüste in halophyten-fluren am westl. Nordufer des Toten Meres ca. 300 m a.s.l unter NN., 17 May 1980, B. Nowak, (B-100480074, photo!); Madaba. östl. Totes Meer, Wadi Mujib., 09 April 1989, C. Bayer, (B-100191808 and B-100191815, photos!). **KUWAIT:** Kuwait, As Sulaybiyah, 15 March 2013, 29° 19′ 10″ N, 47° 51′ 40″ E, M. Abdullah MTA346, MTA349 and MTA352 (E-00678509, E-00678529, E00684254, photos!). **SAUDI ARABIA:** Al-Abard, Abha City, Asir. Saudi Arabia Kingdom, 2380 m a.s.l, 11 August 1998, 18° 32′ 38N - 42° 25′ 12E, T. Miyazaki No. 990811AB23 (E-00614671, photo!). **UNITED ARAB EMIRATES:** Prope Dscheddam in littore maris rubri, Schimper 1837 no. 867, (HBG506283, photo!); Ayn al Faidah area, in coastal area and Al Ais area, Salty, sandy soil, s.l. to 200 m a.s.l, December 1989, M. Jongbloed, BYU2 (BRYV-0213632, photo!). **YEMEN:** SE de Yithab, Wadi Najar, Hadramaout, 1000 m, 19 January 1978, T. Monod 17312, (P-00601497, photo!); Sud Yemen: Ju'aimah, NNE de Shiban, Wadi, Hadramaout, 3 January 1978, T. Monod 16905, (P-P00601498, photo!). **SOMALIA:** Cote française des Somalies, Cote mer Rouge, April 1956, E. Chedeville 1633 (P-P04941770, photo!). **ETHIOPIA:** Hararghe prov., Ogaden, Gode, narrow patch of riverine forest along the Webbe Shibeli River, 300 m a.s.l., 1 December 1969, about 6° 00′ N, 43° 30′ E, De Wilde no: 5968, (WAG-1330801, photo!). **ASIA:** *Schanginia baccata*, P-06590542, P-04989863, P-04989864, P-04989866, P-04989868, and P-04989941 photos!); *Suaeda baccata*, (P-04989862, P-04989865, P-04989938, P-04989939, photos!); Suaeda aegyptiaca, (P-04989936 and P-04989937, photos!).

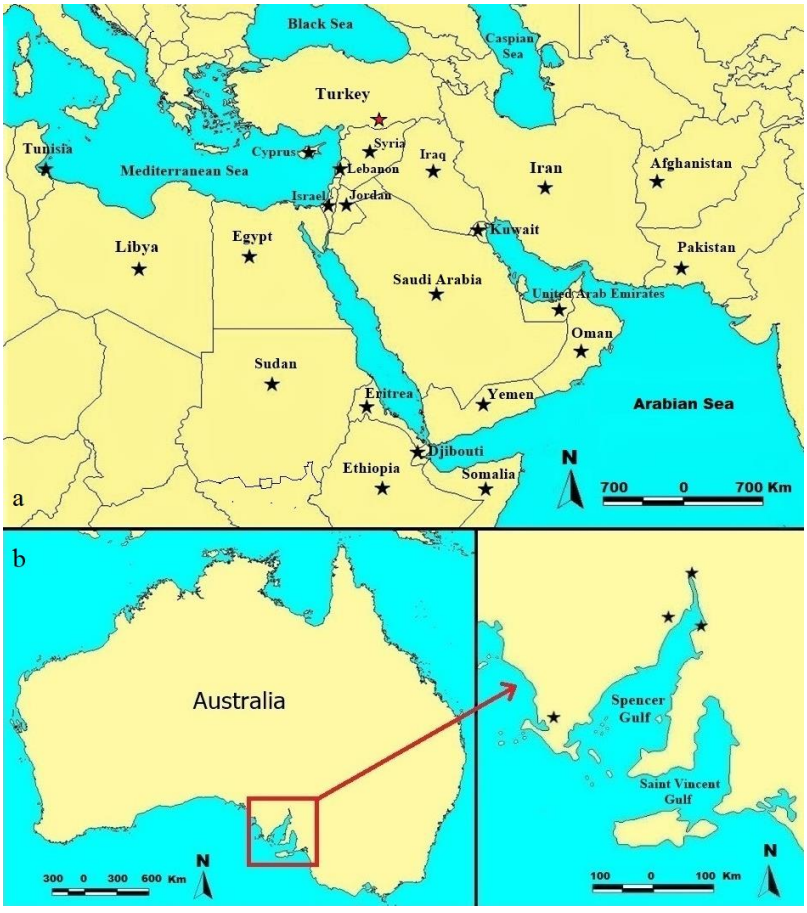

Fig. 1. The distribution map of *Suaeda aegyptiaca* in world with the new record, a. General distribution (Asia, Africa and Arabian Peninsula) Red star indicate the new record, b. It is naturalized in Australia.

Fig. 2. Habitus, leaf, flower, and fruit structures of *Suaeda aegyptiaca*, a. Appearance in flowering time, b. Flower structure, c. Appearance in fruiting time, d. Infructescence, e. Leaf structure, f. Habitat.

Discussion

Suaeda aegyptiaca was classified under different sections by different authors since the 1800s. The study conducted by Moquin-Tandon in 1831 classified the species under the section *Suaeda*. Other studies conducted by Moquin-Tandon in 1840, by Volkens in 1893 and by Ulbrich in 1934 classified the species under the section *Schanginia* (C.A. Mey.) Volk. The study conducted by Schenk and Ferren in 2001 classified the species under the section *Immersa* Townsend. Within the scope of the molecular and morphological study conducted by Schütze *et al.* (2003) on *Suaedoideae* subfamily, the species was classified under the section *Salsina* Moq. Also, in this study, the species classified under the section *Salsina*, based on the study by Schütze *et al.* (2003) and its morphological characteristics.

In the genus *Suaeda*, taxa of the section *Salsina* consists of short trees, shrubs or dwarf-shrubs. Their leaves are either sessile or short petiolate and have the *Suaedoid* C4 anatomy (Schenk & Ferren 2001). Their flower clusters arise from the leaf axil and have a radial symmetry. The number of stigma is three or two and they have a long, thick and papillate structure. Seeds are horizontal or vertical, lenticular, vary in color and size, but not distinctly dimorphic, and they are bright and have a reticulate, punctate or smooth surface (Schenk & Ferren

2001). The type species of the section is *Suaeda vermiculata* Forssk. ex. J.F.Gmel.

In the protologue of *Suaeda aegyptiaca* (≡*Chenopodium aegyptiacum*), morphological definitions of stigma, style and the ovary are provided briefly as "*Germen brevissimum, vix distinguendum. Stylus conicus, crassiusculus, longitudine staminum, integerrimus. stigma bifidum, coronatum laciniis reflexis*" (Hasselquist 1757). However, in the protologue there is no information about bract and bracteole morphologies. After investigating the specimens, we have provided a detailed description of pistil (stigma, style and ovary), bract and bracteole. According to our investigations, Pistil: 1, 2-3 carpellary, 1-lolcular, 2.20-4.50 mm; stigmas 2-3, 0.80-1.75 mm, filiform, with long papillate, light brown; style 0.55-1.30 mm, terete or partly conical, membranous; ovary inferior, 0.75-2.0 x 0.5-2.0 mm, obconical, brown (Figs 3K, K'); Bract: 1, 1.0-1.7 x 0.5-1.0 mm, ovate, ovate-deltoid or deltoid, scarious, either with entire or lacerate margin, apex acute or acuminate and as long as bracteoles (Figs 3B, C); Bracteoles 2, 0.6-1.5 x 0.3-0.8 mm, ovate, scarious, only adnate in basal part, apex acute or acuminate, with lacerate margin (Figs 3B, D, D').

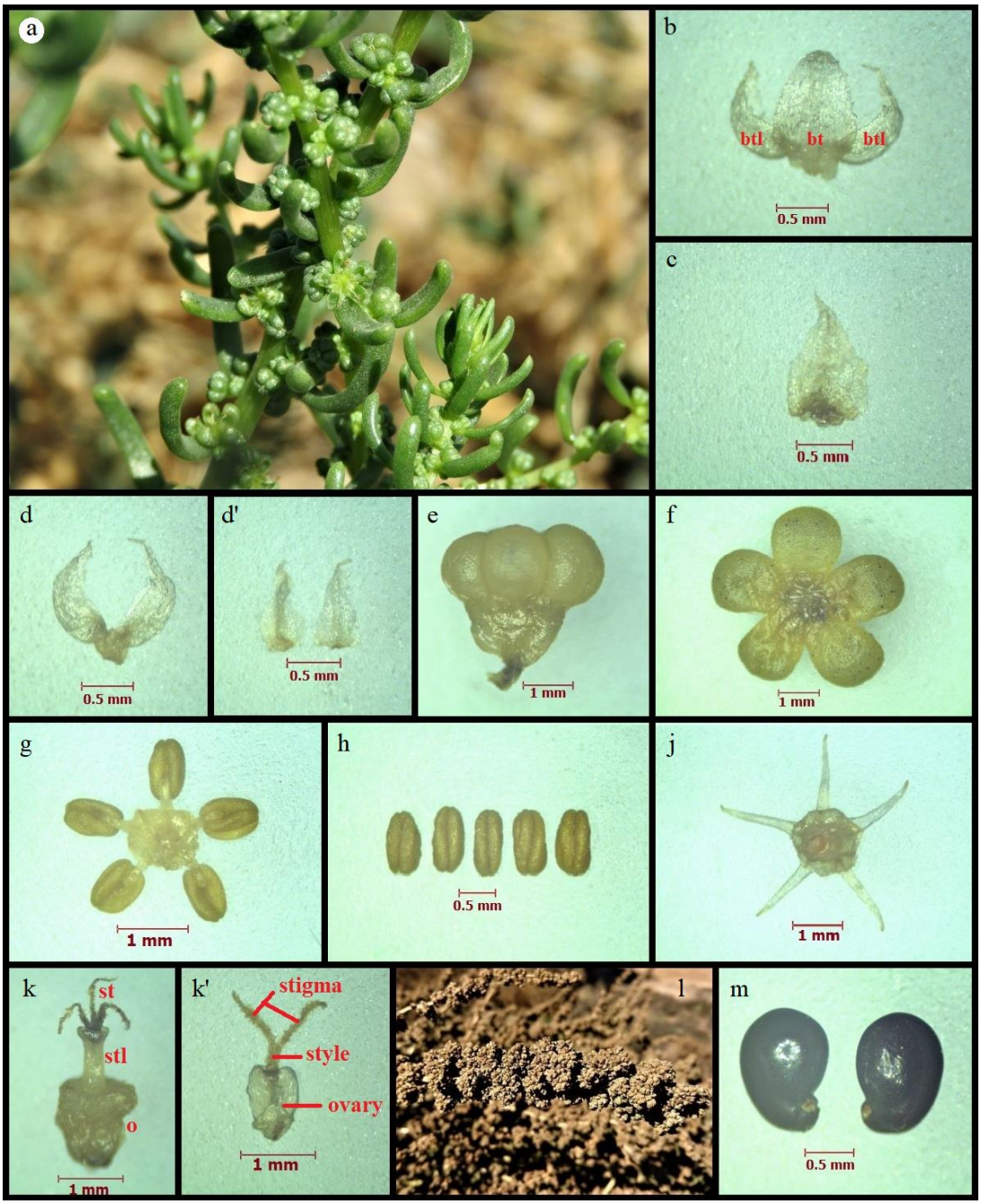

Fig. 3. Morphological characteristics of *S. aegyptiaca*, a. Inflorescence, b. Bract and bracteoles (bt: bract, btl: bracteol), c. Bract, d-d'. Bracteol, e. Flower, f. Perianth segments, g. Stamens, h. Anthers, j. Filaments, k-k'. Pistils (st: stigma, stl: style, o: ovary), l. Fruits, m. Seeds.

In the descriptions of the species in recent literature, morphological features of pistil (stigma, style and ovary), bract and bracteole structures were given incompletely or insufficiently, or were not given at all. Although the study conducted by Meikle (1985) presents the morphological characteristics of the pistil (stigma, style and ovary) structure of the species as "*ovary glabros, pyriform, about 1.5 mm long, 1 mm wide at base; stigmas 3, about 0.4 mm long*", the characteristics of the stylus structure are not explained. Also, it is indicated that the bract structure of the species is "*similar to the leaves, but generally less than 1 cm*" and the bracteoles are "*membranous, erose at apex, broadly ovate, about 0.5 mm long and almost as wide*".

The study conducted by Zohary (1966) provides no information about the morphological characteristics of the pistil (stigma, style and ovary) structure of the species. On the other hand, it is indicated that the bract structure of the species is "*much longer than flowers*", while bracteoles are "*minute and scarious*".

Although the study conducted by Freitag (2001) gives the characteristics of the pistil (stigma, style and ovary) structure of the species as "*Ovary semi-inferior, in its lower, ovule-bearing part fused with the perianth, its upper part forming a ca. 1 mm long column or slender cone; stigmas (2)3(4), 0.7-1.2(1.5) mm long*, with long *papillae, inserted in the center of the collar-like ovary apex*", the characteristics of the style structure are not explained. Also, it is indicated that the bract structure of the species is "*subclavate to clavate, arcuate, spreading, the lower much longer, the upper as long as or even shorter than floral*" and the bracteols are "*0.8-1 mm long, narrow ovate, trullate or triangular, acute or acuminate, the margins lacerate to toothed*".In the fomer studies mentioned above (Zohary (1966, Meikle 1985, Freitag 2001), the structure defined as bract is actually a "leaf" structure which exists in the inflorescence and the structure defined as bracteole is actually "bract" and the characteristics of this structure coincide with the characteristics of the bract structure in our study. From these new findings, it can be understood that the study by Zohary (1966), Meikle (1985), and Freitag (2001) gives no information about the actual bracteole structure of the species.

Finally, the study conducted by Boulos in 1999 only includes the information "*ovary ovoid; stigma 3-4*" regarding the pistil (stigma, style and ovary) structure of the species and does not explain the characteristics of the style structure. Also, it is indicated that the bract of the species is "*bracts 1 mm, deltoid-ovate, with scarious margins*". The study determined that the characteristics of this structure coincide with the characteristics of the bract structure in our study. In addition, the study by Boulos (1999) provides no information about the actual bracteole structure of the species.

We collected some *Suaeda* specimens during the fieldwork conducted in the province of Akçakale district of Şanlıurfa province between the years 2018 and 2019. The identification of the specimens as *Suaeda aegyptiaca* revealed the presence of the species in Turkey, and the number of species of the genus *Suaeda* in Turkey increased to 10.

Conclusion

With this current study, **1)** the presence of the *Suaeda aegyptiaca* in Turkey was revealed for the first time and its extensive description including the distribution area, habitat and morphological characteristics was provided, **2**) the deficiencies concerning the pistil (stigma, stylus and ovary) structure which was not explained properly in most of the recent literature were overcome although clearly specified in the original description, **3)** faulty or inadequate data concerning the bract and bracteole structures which were explained incorrectly or inadequately in most of the literature including the original description was corrected, **4)** and finally it is revealed for the first time that the inflorescence of the species is leafy (Figs 2B, E, 3A).

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Ethics Committee Approval: Since the article does not contain any studies with human or animal subject, its approval to the ethics committee was not required.

Author Contributions: Concept: İ.B., Writing: İ.B., A.E.Y., Critical Review: İ.B., A.E.Y.

Conflict of Interest: The authors have no conflicts of interest to declare.

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